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(54) High-pressure sodium vapour discharge lamp

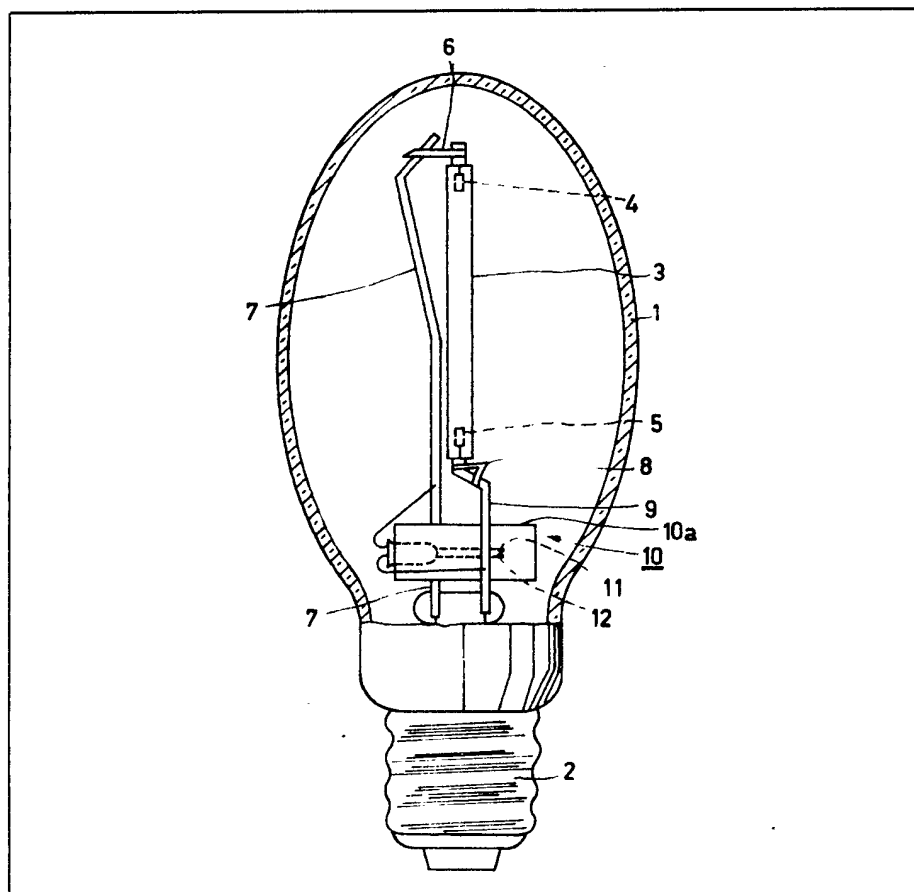
(57) The invention relates to a high-pressure sodium vapour discharge lamp (1) comprising a discharge vessel (3) with a ceramic wall. The discharge vessel also comprises xenon which, during operation of the lamp, has a pressure of at least 50 kPa. The power consumed by the lamp during operation is at most 200 watts.

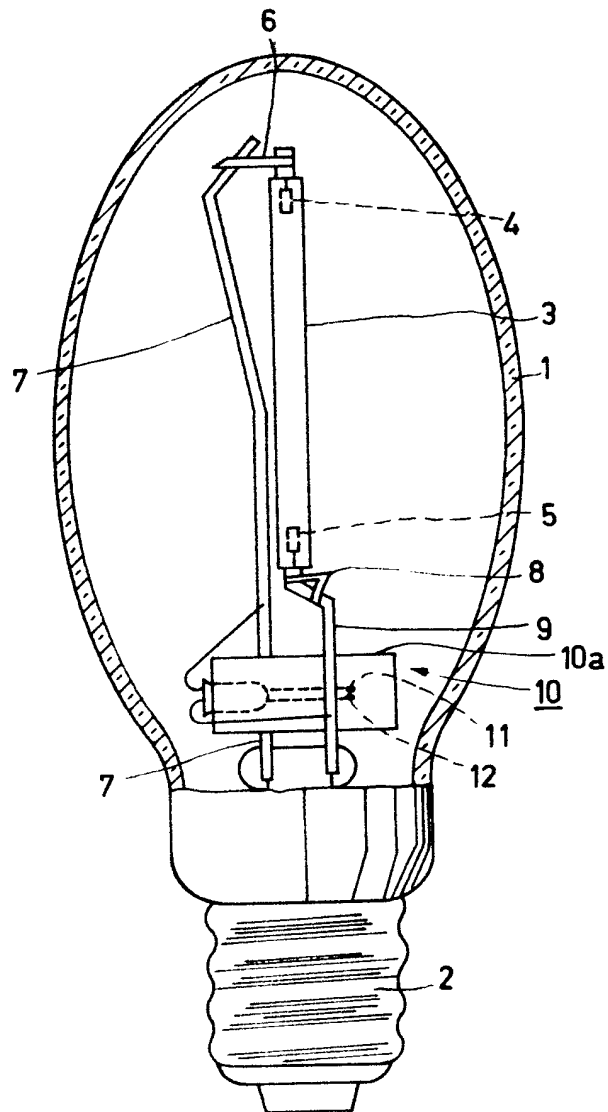
According to the invention the wall of the discharge vessel has a thickness the value of which is smaller than 0.5 mm and is at least 0.2 mm, eg. 0.45 mm or 0.3 mm.

In this manner a lamp with increased specific luminous flux is obtained.

The discharge vessel may be constructed from polycrystalline material, eg. densely sintered aluminium

oxide, of which at least 80% of the crystals have a largest dimension of at least 60  $\mu\text{m}$ .





## SPECIFICATION

**High-pressure sodium vapour discharge lamp**

- 5 The invention relates to a high-pressure sodium vapour discharge lamp having during operation a consumed power of at most 200 watts, comprising a discharge vessel having a ceramic eall, in which vessel two electrodes are present between which in the operating condition of the lamp the discharge takes place, said discharge vessel having a filling comprising sodium, mercury, and xenon, the xenon in the operating condition having a pressure of at least 50 kPa. 5
- 10 Such a lamp is now used on a large scale and is disclosed in Netherlands Patent Application 7704131 (PHN 8762). A high specific luminous efficacy can be obtained with these lamps. The xenon serves as an extra buffer gas besides the mercury. The buffer gases restrict the conduction losses in the discharge vessel during the operating condition of the lamp. In these lamps having a comparatively high xenon pressure the conduction losses are considerably 10
- 15 smaller than in lamps having only mercury as a buffer gas. It has been found that in the known lamps during operation the highest temperature of the wall of the discharge vessel is lower than in a comparable lamp having only mercury as a buffer gas. This results in a restriction of the achievable specific luminous efficacy. This applies in particular to lamps having a small consumed power, notably smaller than 200 watts. It is the object of the invention to provide a measure with which this disadvantage is at least partly removed. 15
- 20 A high-pressure sodium vapour discharge lamp of the kind mentioned in the opening paragraph is characterized according to the invention in that the wall of the discharge vessel has a thickness of less than 0.5 mm and at least 0.2 mm. 20
- 25 In a high-pressure sodium vapour discharge lamp according to the invention the specific luminous efficacy is increased as compared with the known lamp which currently uses a wall thickness of 0.6 mm. It is assumed that this increase is to be ascribed *inter alia* to the increased temperature of the comparatively thin wall of the discharge vessel. Such an increase in temperature often results in a flatter curve of the radial temperature profile of the filling of the lamp envelope. It has been found that such a temperature profile is favourable to obtain a 30
- 30 higher specific luminous efficacy. An advantage is that the wall of a discharge vessel having a thickness in the indicated range has proved to be capable of withstanding attack by the filling of the discharge vessel also during the life of the lamp; which result was not to be expected. 30
- 35 If the wall thickness is chosen to be smaller than 0.2 mm, inevitable impurities of the wall material and lattice defects in the wall will result in such weak spots in the wall of the discharge vessel that the discharge vessel is either not completely gas-tight, or shows a fracture. A non-gas-tight discharge vessel gives rise to disappearance of constituents of the discharge vessel filling from the discharge vessel during the life of the lamp. In the operating condition of the lamp this is expressed in a strong rise of the arc voltage and a variation of the colour point of the radiation emitted by the lamp. 35
- 40 A ceramic wall is to be understood to mean herein a wall of polycrystalline material, for example, densely sintered aluminium oxide, or of a monocrystalline material, for example sapphire. 40
- 45 It is to be noted that an improved temperature profile could be reached by reducing the inside diameter of the discharge vessel. It has been found, however, that in lamps having a power smaller than 200 watts such a measure has the disadvantage that during normal operation of the lamp from an alternating voltage source the required reignition peaks become larger as a result of strong cooling of the discharge during the current passage through zero. The overall lamp efficiency is also detrimentally influenced. 45
- 50 The wall of the discharge vessel of a high-pressure sodium vapour discharge lamp according to the invention is preferably constructed from polycrystalline material of which at least 80% of the crystals have a largest dimension of at most 60  $\mu\text{m}$ . The advantage of this is that on the one hand a good gas-tight wall is obtained without on the other hand adversely influencing the light transmission through the wall by crystal boundaries and lattice defects. 50
- 55 An embodiment of a lamp according to the invention will now be described in greater detail with reference to the accompanying drawing. 55
- 60 In the drawing, an outer envelope 1 of the lamp is provided with a lamp cap 2 at one end. A discharge vessel 3 is present within the outer envelope. The discharge vessel 3 is filled with sodium, mercury, and xenon in such a quantity that in the operating condition of the lamp the xenon pressure is larger than 50 kPa. The discharge vessel 3 encloses two electrodes 4 and 5 between which the discharge takes place during operation of the lamp. Electrode 4 is connected to a rigid supply conductor 7 by means of a metal strip 6. This supply conductor 7 leads to a connection member of lamp cap 2. The electrode 5 is connected to a rigid supply conductor 9, also *via* a metal strip 8, which leads to another connection member of the lamp cap 2. 60
- 65 Reference numeral 10 denotes a glow discharge starter which has a glass envelope 10a. The glow discharge starter comprises two bimetal contact strips 11, 12 of which one is connected to 65

the rigid supply conductor 7 and the other is connected to the rigid supply conductor 9.

The discharge vessel 3 of the lamp described consists of densely sintered aluminium oxide of which at least 80% of the crystals have a largest dimension of at most 60  $\mu\text{m}$ . The wall thickness is 0.45 mm.

5 The manufacture of the discharge vessel started from a mixture of aluminium oxide powder 5  
containing 0.1 to 0.2% by weight of MgO. The mixture was kneaded with a binder (for example  
methyl cellulose) and water to form a plastic mass and was brought to the desired shape by  
extrusion. The extruded powder mixture is then subjected to a two-stage sintering process as  
described in German Patent Specification 2,313,760 (PHN 6236). In the process, the extruded  
10 tube shape in the first step is heated in air for 1 to 3 hours at a temperature between 1100°C to 10  
1400°C. In the second step the heating is carried out at 1800°C to 1900°C for 2 to 6 hours  
while leading through hydrogen.

In the operating condition the lamp described consumes a power of 70 watts when connected  
to an alternating voltage source of 220 volts, 60 Hertz via an inductive stabilization ballast of  
15 approximately 0.6 H. 15

The most important parameters of the lamp described are recorded in column 1 of the Table  
below and those of a second lamp according to the invention are recorded in column 2. The  
lamp according to column 2 is identical to the lamp according to column 1 as regards  
construction, but has a different xenon operating pressure. For comparison, columns 3 and 4  
20 state the parameters of two prior art lamps, in which the discharge vessel has a larger wall 20  
thickness and is constructed from coarser granular material. Otherwise the construction of the  
lamps according to columns 3 and 4 is identical to that of the lamps according to the invention.

Table

25	column	lamps according to the invention		prior art of lamps		25
		1	2	3	4	
30	supply source (V,Hz)	220.50	220.50	220.50	220.50	30
	lamp power (W)	70	70	70	70	
	electrode spacing (mm)	31	31	31	31	
	inside diameter discharge vessel (mm)	3.8	3.8	3.8	3.8	
35	wall thickness (mm)	0.45	0.45	0.6	0.6	35
	xenon pressure in the operating condition (kPa)	320	709	320	709	
	weight ratio mercury: sodium	5.7	5.7	5.7	5.7	
40	maximum wall temperature (K)	1460	1430	1420	1380	40
	specific luminous efficacy (1m/W):					
	after 100 hours in operation	102	110	97	105	
	after 2000 hours in operation	97	107	95	100	
45	after 3000 hours in operation	95	110	92	97	45
	arc voltage variation after 2000 hours in operation (V)	- 1	+ 1	- 4,5	- 6	

50 From the Table it can be seen that, in the case of the lamps according to the invention, the 50  
specific luminous efficacy is approximately 5% higher as compared with lamps not according to  
the invention. This gain in specific luminous efficacy proves to be maintained during the life of  
the lamp.

In another example of a lamp according to the invention the discharge vessel has a wall  
55 having a thickness of 0.3 mm. The xenon pressure during operation of the lamp is approxi- 55  
mately 1.06  $10^3$  kPa and the maximum wall temperature is approximately 1560 K. The lamp  
consumes a power of 70 watts and after 100 hours in operation has a specific luminous efficacy  
of 113 1m/W. After 2000 hours in operation the specific luminous efficacy is 112 1m/W.

The wall of the discharge vessel consists of densely sintered aluminium oxide of which at least  
60 80% of the crystals has a largest dimension of at most 60  $\mu\text{m}$ . 60

The arc voltage after 2000 hours in operation has increased by 3 volts while the indices of  
the colour point of the emitted radiation during the period of 2000 hours in operation have the  
following values:

- 0 hours in operation  $x = 0.544$ ;  $y = 0.425$
- 100 hours in operation  $x = 0.544$ ;  $y = 0.425$
- 1000 hours in operation  $x = 0.541$ ;  $y = 0.423$
- 5 — 2000 hours in operation  $x = 0.541$ ;  $y = 0.424$ . 5

This indicates that the filling of the discharge vessel during the 2000 hours in operation has remained substantially constant in quantity and composition.

## 10 CLAIMS 10

1. A high-pressure sodium vapour discharge lamp having during operation a consumed power of at most 200 watts, comprising a discharge vessel having a ceramic wall, in which vessel two electrodes are present between which in the operating condition of the lamp the discharge takes place, said discharge vessel having a filling comprising sodium, mercury, and  
 15 xenon, the xenon in the operating condition having a pressure of at least 50 kPa, characterized  
 in that the wall of the discharge vessel has a thickness of less than 0.5 mm and at least 0.2  
 mm. 15
2. A high-pressure sodium vapour discharge lamp as claimed in Claim 1, characterized in that the wall of the discharge vessel is constructed from polycrystalline material of which at least  
 20 80% of the crystals have a largest dimension of at most 60  $\mu\text{m}$ . 20
3. A high pressure sodium vapour discharge lamp substantially as hereinbefore described with reference to the accompanying drawing.

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